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Distribution and Habitat Use of Sharp-shinned and Cooper's Hawks in Arkansas

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Cooper's (*Accipiter cooperii*) and Sharp-shinned (*A. striatus*) Hawks are considered uncommon to rare residents of Arkansas by the Arkansas Game and Fish Commission (K. Rowe pers. comm.). Only casual observations on nesting attempts by the two species have been reported in Arkansas (James and Neal 1986), and no recently-confirmed nesting attempts have been reported (K. Rowe, T. Foti pers. comm.). This lack of nesting data has been due to the inability of Breeding Bird Surveys or other contemporary bird monitoring techniques to detect nesting accipiters (Rosenfield and Bielefeldt 1993). This study was undertaken to conduct a survey of nesting Sharp-shinned and Cooper's Hawks and to describe the nesting habitats used by these species in Arkansas.

Methods

Nest locations were found by using three methods. First, posters requesting the reports of Cooper's Hawk and Sharp-shinned Hawk sightings were distributed to four Arkansas State Parks, two USDA Forest Service offices and the Arkansas Natural Heritage Commission office in the spring of 1994. Second, the Arkansas Game and Fish Commission and three university ornithologists were contacted for information on the locations of historic nest sites of both species. Third, I arbitrarily selected forested areas that appeared to fit the habitat parameters described in the literature (Reynolds et al. 1982, Wiggers and Kritz 1991, Rosenfield and Bielefeldt 1993, Rosenfield et al. 1995) and searched them on foot for evidence of nesting accipiters.

The literature indicated that pine plantations and pure coniferous forests were used by accipiters, especially by Cooper's Hawks (Bosakowski et al. 1992a, 1992b). Therefore, most of the forest stands searched were pine plantations, but several deciduous stands were also examined. Each forest stand was first systematically searched using a Johnny Stewart Game Caller to broadcast calls of Cooper's Hawks and Great-horned Owls (*Bubo virginianus*) from roadsides or forest edges to solicit responses from potential nesting accipiters (Stewart et al. 1996, Rosenfield et al. 1985, Fuller and Mosher 1981). Calls were broadcast for approximately 20 sec followed by a 60-sec observation period, then repeated again. If an accipiter responded to the tape, it was followed if observed, or its approximate location was determined from vocalizations. If no responses were heard after approximately 5 min of call broadcasting, the forest stand was systematically searched on foot to rule out the presence or absence of accipiters.

When nests were located, occupancy was verified by the presence or absence of adult hawks, freshly molted down or feathers, white wash (mutes) or young in the nest. If nest structures were considered to be unoccupied during the early part of the season, they were revisited later in the season to verify their status. If young had already hatched, the number of young and unhatched eggs were counted by climbing adjacent trees, or by using a telescoping pole and mirror to look into nests. Most nests were climbed when young were 12–14 d of age in order to determine nesting success and band them.

Habitat measurements were taken after the nestlings had reached fledging age (30–34 d) (Meng and Rosenfield 1988) or had left nests. The nest site was defined as a 10-m radius plot centered on the nest tree. Habitat variables such as canopy closure, canopy height and understory height were measured to define the vertical vegetative structure, while nest tree dbh, forest density (trees/ha) and understory density defined the horizontal vegetative structure (Table 1).

Accipiter and nest site data were analyzed using SPSS 5.0 programs. Two-tailed *t*-tests were conducted to determine any significant differences in habitat types between species. Between-group variance was tested using Levene's tests. Statistical significance was set at $P = 0.05$ A linear multiple regression model was developed for Cooper's Hawk nesting success using a three variable habitat model. The sample size for Sharp-shinned Hawks was too small to conduct a multiple regression analysis However, Pearson correlation analyses were conducted between all variables to detect possible relationships within the samples for both species.

Results

Searches for nesting Sharp-shinned and Cooper's Hawks were conducted in 48 forest stands. Seventy-nine percent of the stands searched were pine forests. They included exotic pine plantations (*Pinus taeda*) and uneven aged shortleaf pine forests (*P. echinata*). The remaining 21% of forests searched were deciduous (oak-hickory forests). These forest stands were distributed widely over 19 counties around the state (Fig. 1).

Four of the 12 occupied Cooper's Hawk nests (33%) were located using broadcasting calls. The other nest sites were found during thorough foot searches of forest stands. All of the Cooper's Hawk nest sites were located in loblolly pine plantations. These forest stands were of medium age (ca. 30–40 yr) and dense (>500 trees/ha) with moderately-dense understories (Table 2). All of the trees used by nesting Cooper's Hawks had diameters >25

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Table 1. Habitat variables and methods used to characterize nest site habitat of Cooper's and Sharp-shinned Hawks in Arkansas, 1994–96.

VARIABLE	PROCEDURE
Forest cover type	Species composition of overstory trees >75%
Forest density (trees/ha)	Number of trees counted within 10-m radius plot centered on the nest tree[a]
Percent canopy closure (%)	Horizontal density board grid (% covered)
Understory density	Index rating from 1–5 with 5 representing greatest density
Understory height (m)	Mean metric clinometer reading from four locations within the 10-m radius plot
Nest tree DBH (cm)	Diameter at breast height of nest tree
Nest tree height (m)	Metric clinometer reading 15 m from nest tree
Stand area (ha)	Measured from aerial photographs or GIS images[b]
Distance to nearest edge (m)	Shortest distance measured from nest tree to stand edge on ground
Distance to nearest water (m)	Shortest distance measured from nest tree to water[c]
Elevation (m)	Elevation of nest site taken from USGS 7.5 min topographic maps

[a] Extrapolated to ha by no. of trees within 10 m radius/(3.14 × r^2) × 10 000.
[b] Used Mapix software GIS Landsat 5 imagery.
[c] Measured using 100 m tape from nest tree to nearest visible water source. Could also be shortest distance to edge.

cm ($\bar{x}$ = 31.2 cm; Table 2). Eighty-three percent of these nests were placed at the canopy base, while two were located well within the live foliage. Cooper's Hawk nest sites were located at a mean elevation of 151.3 m (Table 2). Several nests were located in the same forest stand in consecutive years, but no evidence of returning individuals was available. Therefore, each nest was considered an independent sample for habitat analysis.

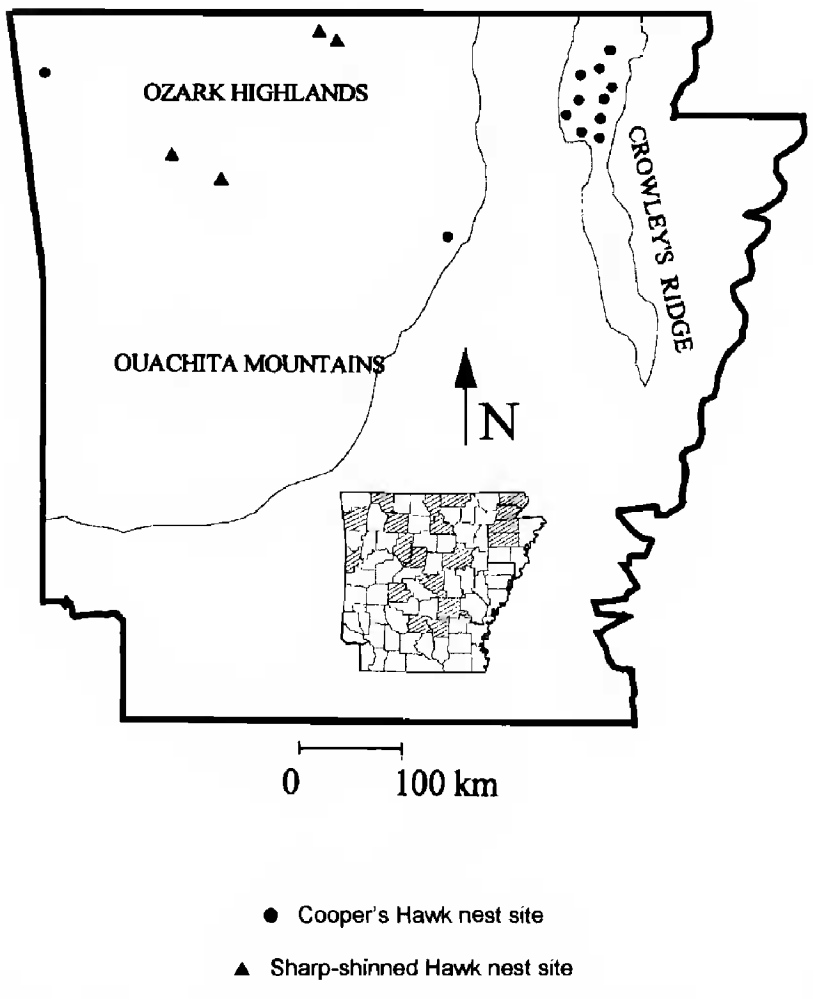

Figure 1. Map of Arkansas indicating counties searched (insert) and locations of Cooper's and Sharp-shinned Hawk nest sites.

One of the four Sharp-shinned Hawk nest sites (25%) was located after broadcasting Cooper's Hawk calls and two were reported by individuals conducting songbird point counts in the Ozark National Forest during 1994. The remaining nest site was located by tracking screaming nestlings heard while searching a forest stand. All of the Sharp-shinned Hawk nest sites were located in uneven-aged, shortleaf pine stands with nest tree diameters ranging from 27.5–31.0 cm ($\bar{x}$ = 29.3 cm). These stands ranged in density from 541–653 trees/ha ($\bar{x}$ = 599.33 trees/ha) and understory densities were moderate (Table 2). The mean nest tree height was 22.0 m and the mean nest height was 18.4 m. All of the Sharp-shinned Hawk nests were placed approximately 1.5 m into the live foliage of nest trees. One of the nest structures was built on a limb 0.85 m from the main trunk while the other three were built next to the main trunk on one or more horizontal branches. Sharp-shinned Hawk nest sites were located at a mean elevation of 343.0 m (Table 2).

Mean forest density was significantly different between Cooper's Hawks and Sharp-shinned Hawks (t = 4.41, P = 0.001; Table 2). Sharp-shinned Hawks were found only in the western part of the state at elevations significantly higher than Cooper's Hawks (t = −5.53, P = 0.002; Fig. 1). Forest stand area ($\bar{x}$ = 54.0 ha) for nesting Sharp-shinned Hawks was also significantly different than those of Cooper's Hawks ($\bar{x}$ = 10.2 ha, t = −9.23, $P < 0.001$) All other habitat variables were not significantly different between the two species (Table 2). Both species used nest sites that had moderate to high understory density (Cooper's Hawk mean index = 3.17, Sharp-shinned Hawk mean index = 3.25), but understory height, while not significantly different, was shorter and slightly more dense at Sharp-shinned Hawk nest sites (Table 2).

Table 2. Mean habitat measurements of Cooper's ($N = 12$) and Sharp-shinned ($N = 4$) Hawk nest sites in Arkansas (1994–96).

	COOPER'S HAWK		SHARP-SHINNED HAWK		
HABITAT PARAMETERS	$\bar{x}$	SE	$\bar{x}$	SE	P
Forest density (trees/ha)*	935.7	69.0	599.3	32.4	0.001
Canopy closure (%)	71.3	1.52	62.5	6.6	0.280
Nest tree DBH (cm)	31.2	0.91	29.3	1.8	0.445
Nest tree height (m)	21.4	0.74	21.9	0.59	0.591
Nest height (m)	16.9	0.63	18.4	0.35	0.075
Understory density (1–4)	3.2	0.84	3.3	1.3	0.908
Distance to edge (m)	51.1	5.8	46.5	36.5	0.921
Distance to water (m)	145.6	36.5	47.5	37.5	0.145
Elevation (m)*	151.3	18.1	343.0	29.5	0.002
Forest stand area (ha)*	10.2	1.9	54.0	0.0001[a]	0.000[b]

* Significantly different between the two species ($P \leq 0.05$).

[a] Low sample size did not allow for accurate measure of standard error.

[b] Low sample size did not allow for accurate measure of P value.

Pearson correlation analyses revealed several relationships between habitat variables and nesting success. Cooper's Hawk nesting success improved with increased understory density and later hatch dates ($R = 0.866$, $P = 0.005$ for both correlations). In contrast, Sharp-shinned Hawk nesting success correlations increased with decreased understory density ($R = -0.969$, $P = 0.031$). Interestingly, Sharp-shinned Hawk nest height showed a negative correlation with increased elevation ($R = -0.999$, $P = 0.027$). Cooper's Hawk nest-site selection may have been influenced by available habitat, with nest height increasing with increased nest tree height ($R = -0.654$, $P = 0.021$). Cooper's Hawk nesting habitat variables were entered into a multiple regression analysis with respect to nesting success. Habitat variables showing a relationship with nesting success were understory density, nest tree height and forest density ($R^2 = 0.865$, F = 8 51, $P = 0.03$).

DISCUSSION

Most of my search effort was focused in northeastern Arkansas. Therefore, more Cooper's Hawk nest sites were located in that region. However, searches were conducted for both species in all stands visited around the state. Although one Cooper's Hawk nest, which was unsuccessful, was found in the interior highlands of Arkansas, I felt that breeding Cooper's Hawk densities were lower in that region, except where suitable forest fragmentation existed. Likewise, Sharp-shinned Hawks were only found in northern and western parts of the state, but I do not believe their range was restricted to that region. The small sample of Sharp-shinned Hawks limited statistical inferences about the distribution and habitat parameters used by this species.

The vertical structure of forest stands seemed to be a very important element in nest area use by Cooper's Hawks. All of the nest sites found had similar habitat variables with dominant trees reaching heights of over 20 m and understory species reaching heights of 10–12 m. The resulting space between the upper canopy base and understory may have served as a protective, horizontal corridor through the nest area. This may have reduced the visibility of nests to potential predators from above, such as Great Horned Owls (Rosenfield 1988).

Unlike the results of surveys by Reynolds et al. (1982) and Wiggers and Kritz (1991), Sharp-shinned Hawks in Arkansas nested in forests with tree densities up to 60% lower than nest stands of Cooper's Hawks. Sharp-shinned Hawks also seemed to utilize uneven-aged and mature forest stands more than Cooper's Hawks. This may have been due to the prey base of Sharp-shinned Hawks being more abundant in less dense forest stands with higher understory density. However, forests with similar structure and species composition were searched in lower elevations and no Sharp-shinned Hawks were detected. One other factor, stand size, may have played an important role in the distribution of accipiters. The interior highlands of Arkansas contain many large contiguous tracts of forested land with suitable songbird densities that may be more suitable for Sharp-shinned Hawks than Cooper's Hawks. Likewise, the fragmented forests of eastern Arkansas (especially Crowley's Ridge and the Ozark foothills) may provide more suitable nesting habitat and foraging edge for Cooper's Hawks than Sharp-shinned Hawks.

RESUMEN.—Investigué un total de 48 parcelas de bosque entre 1994–96, incluyendo 38 de coníferas y 10 de bosques deciduos. Localizé 12 nidos ocupados de *Accipiter cooperii* y 4 de *Accipiter striatus*. Los nidos de *Accipiter striatus* fueron encontrados a alturas significativamente mayores en la parte oeste del estado, mientras que los de

Accipiter cooperii fueron encontrados en elevaciones menores en el noroccidente del estado. Todos los sitios de los nidos fueron localizados en bosques de pinos siendo los de *Accipiter cooperii* encontrados únicamente en plantaciones de *Pinus taeda*. Las variables de habitat fueron comparadas entre las dos especies con el fin de identificar diferencias potenciales en los habitats de anidación. El Porcentage de cobertura del dosel, la densidad de sotobosque, la altura del sotobosque, el diámetro del árbol del nido (dap), la altura del árbol del nido, la distancia al borde mas cercano fueron analizados. La distancia a la fuente de agua mas cercana no fue significativamente diferente entre las dos especies. Las variables de habitat que fueron significativamente diferentes incluyeron elevación y densidad del bosque en el área de las parcelas. El incremento en la densidad del sotobosque fue correlacionado con el éxito de anidación para *Accipiter cooperii* $R = 0.866$, $P = 0.005$) y para *Accipiter striatus* ($R = -0.969$, $P = 0.031$).

[Traducción de César Márquez]

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